Serial No. 08/794,475

A telephonic interview was conducted between Examiner Shaw and applicants' representative Robert Showalter on November 3, 1998. Applicant appreciates the courtesy of that interview. During the interview, it was proposed that claim 7 be amended to recite that the main body first portion and the insert are deformed such that the insert is mechanically locked in place in the main body. It was asserted that this feature of the present invention is not taught in the applied prior art. Examiner Shaw agreed. It was further proposed that claim 22 be amended to change its dependency to claim 21. Examiner Shaw agreed that this change would overcome the § 112 rejection.

With this Amendment, applicant has amended claims 7 and 22 in the manner discussed during the interview.

Enclosed herewith is a translation of German document number 2554990. Applicant also wishes to call to the attention of the Examiner commonly assigned, copending patent application U.S. Serial No. 08/975,022 entitled RESISTANCE WELDING ELECTRODE AND PROCESS FOR MAKING, filed November 20, 1997.

In view of the above remarks and amendments, applicant submits that claims 1-22 define patentably over the prior art. Early notification of allowable subject matter is respectfully requested.

Respectfully submitted,

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Enclosure

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Int. Cl.[2]: B 23 K 35/02
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Federal Republic of Germany
German Patent Office

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Disclosure Document 25 54 990

File Number:	P 25 54 990.0
Registration Date:	December 6, 1975
Disclosure Date:	June 16, 1977

Union Priority:

Designation: Electrode for Electrical Resistance Welding

Applicant: Kabel- und Metallwerke [Cable and Metal Works] Gutehoffnungshütte AG, 3000 Hannover

Inventor: Borgelt, Ralf, 4541 Ledde; Hecht, Meinhard, Dipl. - Ing., 4507 Hasbergen; Lichter, Ferdinand, 4513 Belm

Documents to be considered when reviewing for suitability to patent:

DT-PS	6 37 547
DT-AS	20 24 943
DT-OS	15 65 318
DT-OS	20 45 431
DT-OS	21 62 501
DT-OS	24 18 686
DT-OS	25 18 308
US	23 17 681
US	35 92 994

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MEMO

TO: Stephen A. Calogero, Esq.
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FROM: Gail Horvath
Germaine Intercultural Center
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DATE: Wednesday, October 21, 1998

RE: Docket No. NIP 055 PB
TR 4615-G
German patent document

MESSAGE: I am sorry that you did not receive the copy of the translation which we sent with the invoice on August 14, 1998. (The invoice has been paid.)

I enclose another copy of the translation.

Regards.

2554990

Kabel- und Metallwerke [Cable and Metal Works]
Gutehoffnungshütte Aktiengesellschaft [Limited Corporation]

2 166
December 4, 1975

Patent Claims

1. Electrode made of copper or a copper alloy of high conductivity for electrical resistance welding, characterized by one part of the contact surface consisting of a material of high conductivity and the remaining part consisting of at least one material of increased high-temperature strength.

2. Electrode, based on Claim 1, characterized by arranging the material of increased high-temperature strength in the center of the contact surface and surrounding it by the metal of higher conductivity.

3. Electrode, based on Claim 1 or 2, characterized by the electrode consisting of at least three different materials, the conductivity of which increases from the inside to the outside and the high-temperature strength of which increases from the outside to the inside.

4. Electrode, based on Claim 1 or one of the following, characterized by the material of high-temperature strength consisting of a hardenable copper alloy.

5. Electrode, based on Claim 1 or one of the following, characterized by the material of high conductivity consisting of a hardenable copper alloy with 0.4 - 0.7 % chromium and 0.05 - 0.15 % zirconium and the material of high-temperature strength consisting of a hardenable copper alloy with 1.6 - 2.2 % cobalt and 0.2 - 0.6 beryllium.

6. Electrode, based on Claim 1 or one of the following, <u>characterized</u> by the material of high-temperature strength consisting of a dispersion hardened copper alloy.

7. Electrode, based on Claim 1 or one of the following, <u>characterized</u> by the material of high-temperature strength consisting of heat resistant metals such as tungsten, molybdenum, or a similar metals.

8. Process for the manufacture of an electrode based on Claim 1 or one of the following, <u>characterized</u> by drilling a pocket bore into the contact surface of the electrode, subsequently heating the electrode, inserting a tight fitting bolt of the material of high-temperature strength into the bore, and cooling the electrode.

9. Process for the manufacture of an electrode based on Claim 1 or one of the following, <u>characterized</u> by drilling a hole into a block of copper or a copper alloy, inserting a bolt of metal of high-temperature strength into the hole, after heating pressing the composite block in a extrusion press, and if indicated, heat-treating the semifinished product.

10. Process for the manufacture of an electrode based on Claim 1 or one of the following, <u>characterized</u> by inserting a rod of a metal of high-temperature strength into a pipe of copper or a copper alloy, extruding and/or rolling the pipe and the rod together to a smaller diameter, and if indicated, heat-treating the semifinished product.

11. Process, based on Claim 8 or one of the following, <u>characterized</u> by cleaning the contact surfaces between the different metals of oxides before combining them.
12. Process, based on Claim 8 or one of the following, <u>characterized</u> by screwing the bolt into the contact surface.

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2 - 166
December 4, 1975

Electrode for Electrical Resistance Welding

This invention concerns an electrode of copper or a copper alloy of high conductivity for electrical resistance welding.

Electrodes for electrical resistance welding are currently known that are manufactured of heat-treatable copper alloys, for example a copper chromium alloy. These electrodes, available under the trade name *Elbrodur*, have prevailed in the market because of their outstanding characteristics for resistance welding. The electrodes' purpose is to provide the current as well as pressure necessary for welding. The electrodes are expected to have high electrical and thermal conductivity as well as high structural integrity at higher temperatures, because they are heated as a result of current passing through them as well as from the additional heat transferred from the welding stock.

As a result of repeated welding actions, the contact surface of the electrode becomes increasingly deformed. This process is called mushroom or mushrooming effect. To achieve a

flawless weld it is therefore necessary to re-machine the contact surface of the electrode after a certain number of welds. However, after reworking the electrode a certain number of times the entire electrode has to be rejected. All efforts up until now to increase the high-temperature strength and thereby the life of the electrode through hardening mechanisms, such as hardening by phase transformation, cold forming, mixed crystal hardening, as well as precipitation hardening and dispersion hardening led in all instances to a more or less pronounced reduction of conductivity and thereby to greater thermal loading.

To minimize the loss of valuable material when the electrode completly wears out, it is already common practice to use an electrode considerably reduced in size, which is mounted in the bore of an electrode holder. The electrode holder consists of a material with good electrical and thermal conductivity and its high-temperature strength against the heat experienced during welding is smaller than the high-temperature strength of the electrode. Through these means the dimensions of the electrode, which consists of high grade and expensive material, can be kept particularly small. The life of the electrode, however, could not be increased through these means. (DT-OS 2 162 501)

The invention is therefore based on the task of finding an electrode for electrical resistance welding the useful life of which is considerably longer than that of currently used electrodes.

This task is accomplished by making a part of the contact surface of a material of higher conductivity and the remaining part of at least one material of increased high-temperature strength.

Thereby the material of increased high-temperature strength, which is ideally arranged at the center of the contact surface, carries the mechanical stresses, while the metal ideally surrounding the material of high-temperature strength and which exhibits higher electrical conductivity, primarily is responsible for the conducting of current and the eduction of the heat that is produced during the welding process. The invention is based on the theory that during electrical resistance welding the largest amount of heat is produced at the weld edges and it therefore arranges the better conducting areas in such a way that the heat can optimally be conducted away by the shortest distance.

A particularly beneficial arrangement of the electrode according to the invention results when the material of increased high-temperature strength consists of a hardenable copper alloy. The remaining electrode material then consists for example of pure copper or a low-alloyed hardenable copper alloy. The following combinations can be used to good advantage:

Center	Remaining Electrode Material
copper-chromium-zirconium-alloy (Cu-Cr-Zr)	copper-cadmium or copper-silver-alloy (Cu-Cd or Cu-Ag)
copper-zirconium-alloy (Cu-Zr)	copper-cadmium or copper-silver-alloy (Cu-Cd or Cu-Ag)
copper-cobalt-beryllium-alloy (Cu-Co-Be)	copper-zirconium, copper-chromium-zirconium, copper-cadmium, copper-silver-alloy (Cu-Zr, Cu-Cr-Zr, Cu-Cd, Cu-Ag)
copper-cobalt-silicon or copper-nickel-silicon-alloy (Cu-Co-Si or Cu-Ni-Si)	copper-cadmium, copper-silver, copper-zirconium, copper-chromium-zirconium-alloy (Cu-Cd, Cu-Ag, Cu-Zr, Cu-Cr-Zr)
dispersion compressed copper alloy (Cu-Al)	copper-cadmium, copper-silver-alloy (Cu-Cd, Cu-Ag)

copper-chromium-zirconium, copper-cobalt-beryllium, copper-cobalt-silicon, etc. (Cu-Cr-Zr, Cu-Co-Be, Cu-Co-Si	dispersion hardened copper alloy (Cu-Al)

Which material combination is finally used depends on the purpose. Under certain circumstances it can be beneficial to use a combination of more than two materials where, according to the theory of this invention, conductivity increases from the inside to the outside and high-temperature strength from the outside to the inside. The material of high-temperature strength can, as mentioned, consist of a dispersion hardened copper alloy. A copper alloy with up to 2 % aluminum is an obvious choice. A further advantageous variation of the invention that is possible is implemented when the material of increased high-temperature strength is chosen from very heat resistant metals such as tungsten, molybdenum or a similar metal. The other electrode material should then preferably consist of a hardenable copper alloy, for example a copper-chromium-zirconium-alloy.

For the manufacture of an electrode according to the theory of this invention several processes are possible. One process consists of drilling a pocket bore into the contact surface of the electrode, heating the electrode, inserting a tight fitting bolt of high-temperature strength material into the bore, and cooling the electrode. This process has the advantage that only a small amount of the relatively expensive high-temperature strength material is required. In order to embed the bolt of the high-temperature strength material tightly into the electrode material, it can be beneficial to profile the outside of the bolt. When the electrode cools, the electrode material will shrink into the textured surface, so that the bolt is prevented from falling

out even if the expansion coefficients of the two materials are different.

A further process for the manufacture of an electrode according to the theory of this invention consists of drilling a hole in metal that conducts heat well, inserting a bolt of high-temperature strength metal into the hole, after heating pressing the block in an extrusion press, and finally heat-treating the semifinished product. It is further possible to insert into a pipe of very conductive metal a rod of high-temperature strength material, to draw out or roll the pipe and rod together to a smaller diameter, and to finally heat-treat the semifinished product. From the semifinished product produced by this process, sections of appropriate length can be cut off and further processed into the electrode.

For all these processes it is important to clean the bonding surfaces of the different metals of oxides and grease. This assures a flawless metallic transition between the different metals. If the different materials both consist of hardenable copper alloys, then the heat-treatment has to be adjusted to the materials in such a way that for both metals an optimum of the required physical characteristics can be achieved, that is high electrical and thermal conductivity for the outer material and high-temperature strength for the inner material. It is also a good idea to screw the bolt of the high-temperature material into the contact surface. That way the large contact surface makes good heat transfer possible.

The invention is further detailed by the schematically presented example in Figure 1.

An electrode (2) is attached to the electrode holder (1) of a resistance welding system by means of a conical seat and/or by means of a threaded joint. The electrode (2) ideally has a pocket bore (3) which is provided for cooling fluid access. According to the theory of the invention, a core (5) of a high-temperature strength material is inserted into the contact surface (4) of the electrode (2). Ideally the end face (6) of the core (5) is smaller than the contact surface (4) of the electrode. This assured that the heat produced during welding can be transferred in the direction of the electrode holder (1) by way of the contact surface (4) surrounding the core (5), so it can be transferred to the cooling fluid in the pocket bore (3). The material of the electrode (2) should therefore have high electrical and thermal conductivity. For this reason pure copper or a highly conductive copper alloy, such as copper-cadmium, copper-silver, and similar others materials, are used as electrode material. But also hardenable copper alloys, such as for example copper-chromium, copper-zirconium, and copper-chromium-zirconium-alloys can be used to advantage, particularly if the core (5) consists of a material of very great high-temperature strength. The core (5) is preferably manufactured of a hardenable copper-alloy, such as for example a copper-cobalt-beryllium, copper-chromium-zirconium, or copper-zirconium-alloy.

To manufacture an electrode according to the theory of the invention at first a pocket bore is drilled into a blank that was, for example, cut off a rod. Into this pocket bore the core (5) material of great high-temperature strength is pressed. To do this it can be useful to either cool the

core (5) or to heat the electrode (2) and to then subsequently equalize the temperature. Through this shrink process the contact surfaces are tightly pressed together. For this process it can be useful to profile the outer surface of the core (5) before the insertion into the bore, for example by knurling, which will lead to a mechanical connection between the core (5) and the electrode (2).

The considerable advantage that an electrode according to the theory of this invention provides, when compared to currently used electrodes, can be clearly seen in the table below. Electrodes made of a copper-cobalt-beryllium-alloy with 2 % cobalt and 0.5 % beryllium (Sample 1), of a copper-chromium-zirconium-alloy with 0.6 % chromium and 0.12 % zirconium (Sample 2), and of a material produced according to the theory of this invention (Sample 3) were compared. The core material consisted of a copper-alloy with 2 % cobalt and 0.5 % beryllium, the outer electrode material of a copper-alloy with 0.6 % Chromium and 0.12 % zirconium.

	Material	Number of Welds
Sample 1:	Cu-Co-Be	2000
Sample 2:	Cu-Cr-Zr	6500
Sample 3:	Cu-Cr-Zr, Cu-Co-Be	10000

This table demonstrates that, very surprisingly, a combination of materials according to the theory of this invention contributes considerably to the life of an electrode. The reason for the poor result of the relatively heat resistant materials Cu-Cr-Zr and Cu-Co-Be is the surpassing of the softening point of these alloys. Because of the poor heat conductivity of these materials, heat accumulation leads to increased thermal stress. Through

the combination of a material that conducts heat relatively well and a material of great high-temperature strength (sample), the core material is intensively cooled so that the softening point is not exceeded.

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[Figure]

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